S&E SCIENCE AND THE ENVIRONMENT Bulletin
JUNE 1998

TESTING FOR CLEANER AIR

Gasoline is one of the world's most heavily consumed commodities, powering everything from lawnmowers to sports cars. Emissions that result from using gasoline are also a major contributor to smog, air toxics and climate change. Millions of tonnes of pollutants are released into the atmosphere each year through combustion and evaporation of gasoline and fuels. Scientists at Environment Canada's Environmental Technology Centre are working to minimize these harmful impacts.

Health Canada is also involved in these efforts through examination of how changes in air pollutants affect Canadians through premature mortality and a variety of respiratory problems.

The growing number of vehicles in the world necessitates improvements in both fuels and engines. This requires a front-end and back-end approach that not only examines the components of these fuels, but also tests how efficiently they burn in various engines by measuring the pollutants that are emitted.

Involved in the front end of this approach in partnership with the Canadian General Standards Board,

Environment Canada works with industry, testing organizations and other federal departments to develop and validate test methods. These tests are used by the Board to define specifications for the content of gasoline and other fuels, and help lead to quality assurance procedures for fuel-related regulations.

Environment Canada's contribution to the process is knowledge of the environmental impacts of certain fuel constituents, and expertise in highly specialized testing methods such as gas chromatography–mass spectrometry and x-ray fluorescence spectroscopy. Used to measure even the most minute quantities of substances in the environment, these methods can also be adapted to examine the complex chemical composition of fuels.

A major focus of the team's work is on developing tests for two fuel components. The first is benzene, regulated in Canada, and a known carcinogen. The second is sulphur, which produces particulate matter that poses a health hazard to Canadians. (A recommendation is expected this fall on a new level of sulphur in gasoline.) The work on tests for sulphur and benzene has resulted in a standardized method of testing for benzene content in exhaust gases to replace the more than half a dozen disparate methods that were used in the past.

To get the full picture, gasoline is also examined from the back end through testing the content of emissions released by fuel combustion in everything from chainsaws to minivans. The data collected are useful not only in directing improvements in engine efficiency and fuel quality, but also in indicating where there may be a need for stronger control programs. Tests assess emissions such as oxides of nitrogen, carbon monoxide and carbon dioxide, as well as measure fuel consumption. There is also an increasing importance placed on the characterization of hydrocarbons, such as volatile organic compounds. These compounds react in sunlight to produce smog and many have an adverse effect on human health.

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Update on passenger transportation emissions in Canada

Following the Harlequin duck by satellite

Monitoring Canada's air quality

Environment Canada Environnement Canada

CARS MORE FUEL-EFFICIENT, BUT CANADIANS DRIVING MORE

Canadians are offsetting the environmental benefits of increased fuel efficiency in their automobiles by driving more. In 1995, 81 of every 100 kilometres traveled by individuals was in an automobile, accounting for more than 40 per cent of all fuel consumption and carbon dioxide (a greenhouse gas) emissions in the transportation sector.

The *Canadian Passenger Transportation Bulletin* reports a 15-per-cent increase in automobile travel between 1990 and 1995. Thus, even with improvements in average fuel efficiency per passenger-kilometre traveled, total fossil fuel use increased by six per cent over the same period.

The Bulletin notes that overall fuel consumption would have actually decreased if not for the increase in automobile travel. In fact, improved fuel efficiency has meant that the cost of driving a given distance in a new automobile has decreased 44 per cent since 1973.

Among its other findings, the Bulletin reveals that Canadians are traveling more by air—90 times more in 1995 than they did in 1950. Travel by both air and car is growing much faster than travel by bus or train. Automobiles and planes use more fuel, and emit more carbon dioxide per passenger for a given distance of travel, than do trains or buses. Public transit represents less than five per cent of motorized travel in urban areas, and, between 1990 and 1995, urban transit ridership actually decreased.

Passenger transportation accounts for more than half of all fuel consumption and carbon dioxide emissions in the transportation sector, and is a major contributor to negative environmental impacts such as climate change, poor urban air quality, and acid rain. The transportation sector, in turn, is the fastest-growing source of greenhouse gas emissions in Canada. Emissions controls are increasingly effective. However, the benefits they provide are being partially offset by several factors: the increase in the number of automobiles, an increase in the total number of kilometres traveled, and the continuing presence of older or poorly maintained vehicles on the road.

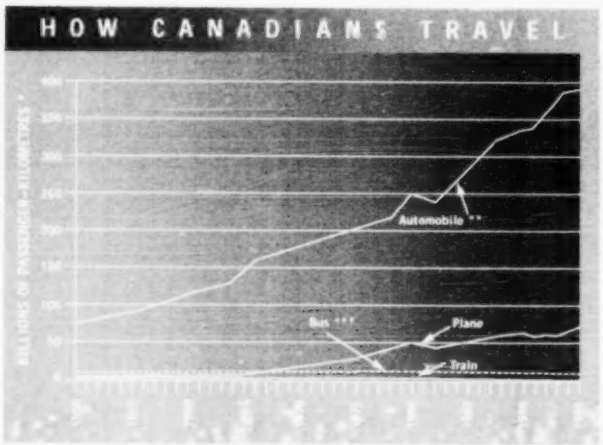
SMOG AWARENESS

Warnings of high smog levels help Canadians to change their behaviour. However, the behaviour changes involve staying inside or cutting back on outdoor activity in order to avoid smog exposure. There seems to be little evidence that warnings bring about behaviour to reduce smog, such as leaving the car at home and using alternative transportation.

These findings are from two surveys conducted by Environment Canada among residents of southern New Brunswick. The first survey was after a 1994 smog advisory program, which issued smog warnings on days when smog levels exceeded 80 parts per billion. The second was in 1997, after the pilot year of another program, in which there were predictions of the smog index, along with public health and educational messages twice daily.

The surveys also found that people were more aware in 1997 of the health hazards posed by smog, particularly respiratory problems and asthma attacks, than they were in 1994. This was probably because more health messages accompanied daily smog forecasts.

The survey results show that public education helps people better understand how to protect themselves. The next step is to find the key to changing behaviours, such as car use, that lead to the creation of such environmental problems.



* Passenger-kilometres = occupancy x distance travelled.
Estimates were used for automobile and bus occupancy rates.
** "Automobile" refers to cars and other private-use passenger vehicles, such as vans and small trucks.
*** Bus" includes intercity and urban bus, plus other forms of urban transit (light rail, subway, etc.).

New motor vehicle emissions standards and fuel efficiency targets in Canada and the United States, as well as innovative technologies and alternative fuels, may result in more choices in cleaner and more efficient vehicles in coming years. The Bulletin notes, however, that positive results from these developments will be slow to show up, as it will be some time before these new vehicles comprise a significant proportion of the fleet of cars on the road.

The entire Bulletin can be obtained from Environment Canada's Inquiry Centre or its Web site. (See BOX on page 4.) **S&E**

SATELLITES AND ENDANGERED DUCKS

A satellite tracking device small enough to fit inside the belly of a bird is helping scientists learn more about the ecology and movement of the Harlequin duck—a coastal-dwelling species in eastern and western Canada. The signals emitted by the device are picked up by orbiting satellites, and the coordinates are transmitted directly to researchers at Environment Canada.

Limited research had been done on Harlequins before the eastern population became listed as endangered several years ago. To help restore the population, scientists need to know more about breeding, nesting and wintering sites—not only to make reliable estimates of the population, but also to protect these areas from human encroachment.

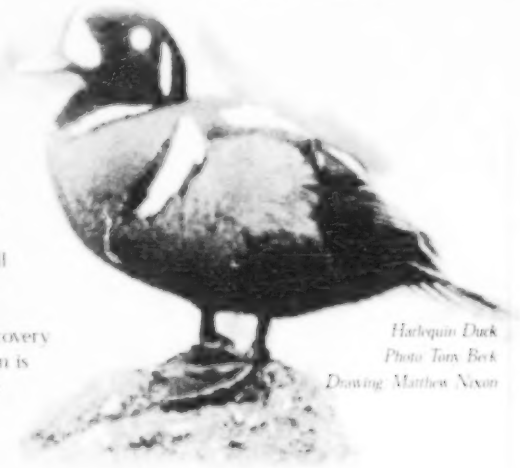
Radio telemetry had been used extensively for tracking animal species in the past. However, the tracking devices were of limited use because of weight and size, and the fact that signals could only be received from a short distance away. In 1996, when the Harlequin project was launched, technology had only just perfected a satellite tracking device that would fit inside a waterfowl without impeding its natural functions.

At 30 gm, the transmitter used to track harlequins is less than five per cent of the weight of a male duck, but still too heavy to be used for females. Implanting the device in the bird's abdominal cavity involves complex field surgery that can take up to an hour to perform.

At $4,000 each, the technology is expensive, and only 12 harlequins have received implants since 1996. Another 12 are scheduled for 1998.

The information gathered from the first 12 ducks has revolutionized knowledge of Harlequins in eastern Canada. Most of the birds were caught on the easternmost tip of the Gaspé coast, and tracked to previously unknown breeding and moulting sites on Quebec's north shore and the coasts of Newfoundland and Labrador. Their migration to Maine, where all previous population estimates were made, confirmed the area as their main wintering site. When several hundred Harlequins were found on the southeast coast of Hudson's Bay, it was thought that they were part of this same population until five were caught and tracked to moulting and wintering sites in Greenland. The unexpected discovery of this second, distinct population is the basis for discussions with the Danish government over a joint management plan for the species, which is still hunted in Greenland.

The success of the Harlequin project has spurred the launch of a similar effort for the Barrow's goldeneye—another duck whose numbers are on the wane. As technological advances make tracking devices more compact, scientists are hopeful that the use of satellite telemetry can be applied to a broader range of species. **S&E**



Harlequin Duck
Photo Tom Beck
Drawing Matthew Nixon

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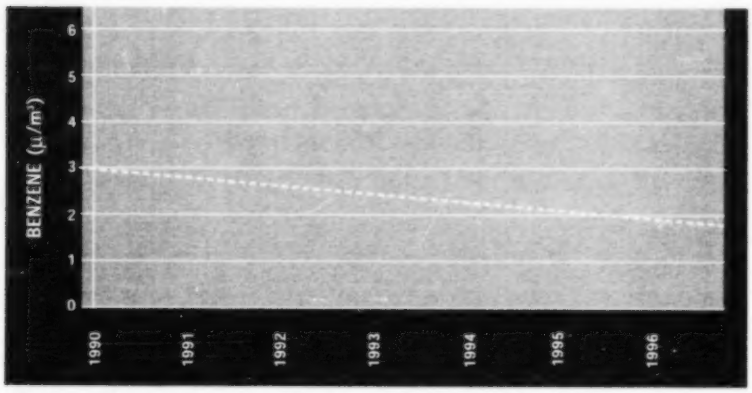
In addition to testing new light-duty vehicles and motorcycles to ensure that engines and emission control components meet federal exhaust emission standards for gasoline, diesel and alternative fuels, emissions testing is also done on alternative fuels such as propane and natural gas. A growing focus of this work is on reformulated fuels, because petroleum producers are changing their products to meet stricter regulations in some U.S. states—adding oxygenates like ethanol to gasoline to improve the combustion characteristics and reduce emissions.

This work has led to several projects involving Environment Canada and the petroleum industry, including comparative tests of the emissions produced by a newly formulated gasoline based on oil-sand bitumen and those of reformulated fuels blended to more stringent specifications. Attempts are currently under way to set up a similar program to look at reformulating gasoline to reduce its carbon content. These and other cooperative efforts to create a superior fuel offer hope for the future—from both an environmental and economic standpoint. **S&E**

KEEPING TRACK OF AIR POLLUTANTS

Since 1969, Canada's National Air Pollution Surveillance (NAPS) network, a federal-provincial venture, has monitored levels of sulphur dioxide, nitrogen dioxide, carbon monoxide, ground-level ozone, lead and suspended particulate matter in our air. It expanded in the mid-80s to include other contaminants.

This monitoring program provides valuable scientific information to tackle key environmental challenges such as smog, toxics, and acid rain. NAPS data also provide the principal ambient air exposure information for 14 toxic substances on a priority list for virtual elimination under the Canadian Environmental Protection Act.



Decline in median ambient air benzene concentrations (μ/m^3) (composite data from 22 urban sites).

The network has traced, for instance, declines in the presence of benzene in urban air between 1990 and 1996. These decreases are due to the introduction of more stringent motor vehicle emission standards, and the reduction of benzene in gasoline. The NAPS network will continue to monitor levels of benzene in ambient air to assess the impact of benzene-in-gasoline regulations, established under CEPA.

Also measured are concentrations of polychlorinated dibenzo-p-**dioxins** and polychlorinated dibenzo**furans**, highly toxic byproducts of waste combustion. Since 1990, the presence of these harmful byproducts in our air has been measured using gas chromatography–high-resolution mass spectrometry. This method has improved detection limits by approximately 20 times while dramatically reducing interference from other chlorinated hydrocarbons. The data generated using this methodology show some reductions in dioxins and furans over the past decade. They also show there are still numerous sources of dioxins and furans in Canada, resulting in recommendations to accelerate reductions in environmental exposure to these toxic substances. Another innovative testing technique is capillary electrophoresis. It has been used successfully to analyze inorganic and organic ions in particulate matter suspended in the air.

Among the substances measured by the NAPS network are:

- volatile organic compounds (VOC): precursors of ground-level ozone, the major component of smog. VOCs include aromatics, aldehydes, and ketones.
- Polycyclic Aromatic Hydrocarbons, or PAH: these are semi-volatile compounds, and include some chemicals that are known or suspected carcinogens.
- Nitro-PAH: these compounds, found in diesel engine exhausts, are emerging as cause for concern because of their potential impact on human health. **S&E**

S&E GUIDE

Science and the Environment Bulletin is published regularly to bring leading-edge environmental science and technology work to Canadians.

More information is also available on **Environment Canada's Green Lane at www.ec.gc.ca.** Many of the publications mentioned in the Bulletin are posted on the Green Lane or can be ordered from the **Inquiry Centre at 1-800-668-6767**, including: the *Canadian Passenger Transportation Bulletin*, www1.ec.gc.ca/~ind/

Readers are encouraged to communicate with us: **e-mail Paul.Hempel@ec.gc.ca** and to visit the Bulletin's Web site at **www.ec.gc.ca/science**

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